an appropriate understanding of drought duration, magnitude and spatial extend in semi-arid areas like Greece. Greece, as it is very often facing the hazardous impacts of droughts, presents an almost ideal case for the SPI application. The methodology followed uses precipitation from 42 meteorological stations located in the country. For the drought assessment the Standard Precipitation Index is calculated for a variety of temporal steps (i.e. SPI 6, 12, and 24). The statistical analysis of the examined temporal step parameters, has also applied the Auto Regressive Model ARIMA (Auto Regressive /Integrated/ Moving Average).Then, forecasting efforts – based on those patterns – are derived and presented. It is believed that such a methodology may provide useful anticipatory information on the area's vulnerability to drought and thus portraying the system's susceptibility to change, damages and losses. In this context, vulnerability may be included in the decision making arsenal in order to also widen existing perceptions of the area's inherent weaknesses and limited resilience to both manmade and natural hazards, serving at the same time as an early warning mechanism.

HF-12

Hydrogeomorphological scaling emergence and robustness through the systematic nesting analysis of a heterogeneous river network

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Within a river basin, the channelized water path from any point to the outlet is split into successive components within the Strahler ordering scheme along the water path. The probability density functions of the length L of the whole channelized path and of the lengths of the components are extracted through a GIS-based analysis and studied as multi-level structural functions. The scaling ratios of characteristic lengths across the Strahler system are also studied, including the bifurcation and length Horton ratios, and the ratio between the average lengths of components. The latter is more related to the functional water paths and fluxes than the length Horton ratio based on topological streams. These metrics are studied for a systematic exploration of nested sub-basins of a 1175 km^2 river basin, with a heterogeneous river network in a calcareous rural semiarid context. It appears that the scaling relationships are quite strong despite the river network heterogeneity, varying across the systematic nesting spectrum. This shows situations of emergence, where scaling is very strong despite some lower scaling evidences upstream. Further, it is shown that the length Horton ratio (based on the average lengths of streams) and the ratio between the average lengths of components are systematically very close, in value and statistical representativeness - which can be justified theoretically.

HF-13

Uncertainty evaluation of permeable area ratio inherent in grid based models

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Introduction - Background and aims: Distributed water circulation models developed for examining hydrological circulation mechanisms employed in practical river basins typically use grid sizes of 10m or larger. In using a grid based model for the analysis of permeation process, the permeable area ratio of each grid is a critical factor. While one grid is assigned with only one dominant land use classification and corresponding permeable area ratio of the respective land use classification, there are in fact wide variety of land uses found even in a minimum unit size in reality. In order to obtain appropriate run-off simulation results, it is necessary to estimate accurate permeable area ratio for each of the 10m-grid. At present, there seems to be no technical papers/reports published on the uncertainties associated

with permeable area ratios. The authors have conducted a detailed land use classification for a typical urban river basin in Tokyo and developed an advanced GIS delineation data which consists of highly detailed polygon layers of such land covers as buildings, roads, rivers, forests instead of assigning such information in on grid data. This study aims to estimate more accurate permeable area ratios for 10m-grids by utilizing the advanced GIS delineation, and to evaluate uncertainties of permeable area ratio inherent in grid based models.
Methods: The authors developed a database of individual land-surface features using advanced GIS delineation in the upper Kanda river basin. 10m-grid land use classification has seventeen different land use types. Area ratios of land-surface features were estimated for each 10m-grid. Each land-surface feature has a permeable or impermeable property. Permeable area ratio of each 10m-grid was estimated by properties of permeation and area ratio of individual land-surface features. Permeable area ratio was also estimated for each of the 10m-grid land use classification. In addition, frequency/spatial distribution of 10m-grid land use classification was determined.
Results – Conclusions: Land use classification breakdown was calculated for each of the 113,394 grids. Furthermore, actual land use distribution was determined for each 10m-grid that are assigned with a dominant land use classification. For example, it was revealed in the study that a grid assigned as "building" actually had building area ratio of about 38%. Spatial distribution of permeable area ratio calculated from properties of permeation and area ratio of individual land-surface features was presented. Differences were observed among the accurate permeable area ratios estimated for 10m-grid, average values set for dominant land uses, and those set by previous studies. The permeable area ratios determined in another study were much bigger or smaller than those estimated by 10m-grids in this study. Even the permeable area ratios for dominant land use classification calculated by averaging 10m-grid permeable area ratios do not represent spatial distribution of permeable area ratio accurately. In conclusion, it is reasonable to say that the proposed permeable area ratios in the upper Kanda river basin is applicable for other urban river basins with similar characteristics, and the methodology presented in this study for determining permeable area ratios would greatly contribute to improving other distributed hydrological models.

HF-14

Propagation of input and parameter uncertainty and dynamical nonlinearities in random self-similar networks

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In this work we address the question of how nonlinearities in rainfall-runoff transformation that occur at the hillslope scale propagate through a random self-similar river network using a theoretical model of runoff generation and runoff transport. We use a system of ordinary differential equations (ODEs) to represent simultaneously the aggregated behaviour of changes in water storage in the surface, the unsaturated and the saturated soil layers of a hillslope/link element. The ODE system can be modified to exhibit nonlinearities observed in data but can also be reduced to a simpler linear system that only captures partially the hillslope dynamics. The ODE system is coupled to a runoff routing scheme to propagate runoff generated at the hillslope scale through the river network to the watershed outlet. We assess the differences in the response across scales for the linear and nonlinear hillslope response models. It is shown that the differences in the hydrographs at larger scales decrease with increasing scale (i.e. upstream basin area). The figure shows differences in the time to peak between a linear hillslope model and a non-linear one observed at different scales. Our results reveal the role of the self-similar river network in smoothing out, not only spatial variability in inputs and parameters, but also aspects of the local-scale complex dynamics. Our work also helps explain how the performance of overly simplified watershed models can be comparable to more sophisticated, realistic and physically based ones.